

Report for 2002NC2B: Reduced Cost Strategies for Regional Integration of Surface and Groundwater Use

- Conference Proceedings:
 - Kirsch, B. R. and G. W. Characklis (2003). An Integrated Analysis of Water Use Alternatives in the Central Coastal Plain Capacity Use Area, Proceedings of the Annual Conference of the North Carolina Water Resources Research Institute, Raleigh, NC, April 2003
- Other Publications:
 - Kirsch, B.R. and G.W. Characklis, April 2003, An Integrated Analysis of Water Use Alternatives in the Central Coastal Plain Capacity Use Area, Annual Conference North Carolina Water Resources Research Institute, Raleigh, NC.
 - Kirsch, B.R. and G.W. Characklis, November 2002, An Analysis of Water Supply Alternatives in the Central Coastal Plain Capacity Use Area: A Regional Supply Model, Annual Meeting of the American Water Works Association/Water Environment, Winston-Salem, NC.
 - Characklis, G.W., September 2003, Interface of Water Resource Engineering with Economics and Public Policy, Frontiers on Engineering Symposium, National Academy of Engineering, National Academics Beckman Center, Irvine, CA.
- unclassified:
 - Characklis, G.W. and B.R. Kirsch, January 2004, Regional Water Supply Management in North Carolina, North Carolina Water Resources Research Institute Seminar Series, Raleigh, NC.

Report Follows

Title

Reduced Cost Strategies for Regional Integration of Surface and Ground-Water Use

Problem and Research Objectives

Fifteen counties in the eastern part of North Carolina have been classified as a “Capacity Use Area”, a designation that provides the legal framework for regulation of groundwater pumping withdrawals. This region, collectively known as the Central Coastal Plain Capacity Use Area (CCPCUA), has traditionally been dependent on groundwater for much of its water supply, however, increasing usage has led to concerns over reductions in aquifer levels and saltwater intrusion. Under rules recently put forth by the State, communities within the CCPCUA will be issued groundwater pumping permits and will subsequently be required to reduce their withdrawals by as much as 75% over the next 16 years. In order to meet this goal, new water sources must be developed and current sources used more efficiently. Conservation will play some role in improving efficiency, but conservation alone will not compensate for the severe reductions in regional groundwater pumping. Regional supply could be augmented via groundwater from the unregulated surficial aquifers, as well as the more distant Castle Hayne formation, however, the surficial aquifers are unlikely to be more than a stopgap measure for most communities, while the location of the Castle Hayne implies high conveyance costs. Surface water (e.g., Neuse, Tar, and Roanoke rivers) is likely to be the primary means of meeting future water demand in the region, but treatment and distribution of surface water is more expensive than that of groundwater and will involve vast amounts of new capital spending. Significant expenditures will also be required for conveyance infrastructure to transport surface water to those communities not in close proximity to surface sources.

This project focuses on the development of a model that minimizes water supply and treatment costs for regional groups of communities. The central contribution of this work is in estimating the cost savings achievable through development of regional drinking water treatment facilities. Results will specify a water asset “portfolio” for each community, composed of a combination of groundwater, surface water, and the yield from conservation activities. The objective of this work is the development of a model that will return combinations of these assets that minimize water supply and treatment costs over a multi-period time horizon as constrained by supply reliability.

Methodology

The model developed in this project will consider:

- (a) Source water(s) (i.e. groundwater, surface water);
- (b) Source water availability (and changes due to pumping restrictions);
- (c) Source water quality;
- (d) Municipal conservation activities;
- (e) Transfers of groundwater pumping permits;
- (f) Distance and elevation difference between source(s) and treatment plant(s);
- (g) Water demand;
- (h) Reliability targets;

- (i) Treatment plant capacity;
- (j) Treatment technology process chain;
- (k) Community characteristics (e.g., size, location, elevation).

Specifically, the model will:

- (1) Compute the *total cost and average cost (\$/1000 gallons) of water supply* for a community or group of communities based on specification of parameters (a)-(k).
- (2) Compute the *minimum total cost and minimum average cost of water supply* for an individually specified community or group of communities based on selection of an optimal combination from given sets of choice variables for (a), (d), (e), and (i).

The model consists of the treatment cost functions and a minimal spanning tree algorithm that optimizes pipeline network configuration. The costs of water supply and treatment for communities acting individually are compared with situations in which some or all of these communities participate in a regional approach.

Principal Findings

The equilibrium approach developed in this work can be an effective tool for exploring the potential advantages of using regionalized surface water treatment and tradable groundwater permits in the pursuit of sustainable groundwater management strategies. The model's recognition of the interdependencies between individual decisions and their collective impact on costs, as well as the assumption that cities act as individuals, may provide a more representative means of modeling many regional scenarios. The approach used also allows for some flexibility in exploring various policy options related to alternative cutback scenarios and localized pumping restrictions in areas of severe aquifer damage. Beyond the methodology itself, it appears that the combined strategy of regionalized surface water and tradable groundwater permits has the potential to yield considerable savings to regions that seek to reduce groundwater withdrawals to sustainable levels. In the case of the CCPCUA, results suggest a potential savings of 35 percent relative to a base case scenario in which all communities act independently.

Significance

Results can be used by Coastal Plain water suppliers to optimize their regional growth plans to most cost-effectively provide water to their users. The modeling framework can be adopted for application in other regions to evaluate water supply scenarios for optimizing water supplies.